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RETURNS TO THE QUESTIONER.

By C. C. Grove.

There still are those who think the professor has an easy time and proceed to help make him earn his "large" salary by asking him questions, with or without a stamp for reply. It seems to be expected that he is a cistern if not a spring, but they forget at what expense a good cistern is built and a gushing spring forced.

Two types of problems have come in rather frequently so that it seems worth while to make them known as a class so that when their simplicity is perceived they need not come any more for solution.

First a simple one: What must I pay annually, beginning at the date of purchase, to pay for a property valued at V dollars and interest at the end of each year at r per cent. for unpaid amount, so that all is paid at the expiration of t years?

The method of solution is to set down the situation at the end of each year in symbolic form and from analogy write out the situation at the end of the transaction; thus,

At end of first year $(V-A)(1.0r)-A$. Amount of unpaid money less A.

At end of second year $V(1.0r)^2-A(1.0r^2+1.0r+1)$. Amount of former balance less A.

At end of third year $V(1.0r)^3-A(1.0r^3+1.0r^2+1.0r+1)$.

At end of tth year $V(1.0r)^t-A(1.0r^t+1.0r^{t-1}+\cdots+1.0r+1)=0$.

Multiplying and dividing the series after A by $(1.0r-1)$, we get

$$V(1.0r)^t-A\frac{(1.0r)^{t+1}-1}{1.0r-1}=0.$$

By taking logarithms of $1.0r$, multiplying by t and $(t+1)$, and finding the antilogarithms of the products, with ease the value of A is found by substituting in

$$A = \frac{.0r \times (1.0r)^{t}}{(1.0r)^{t+1} - 1} V.$$

Second, a more complicated problem: A city wishes to issue 6 per cent. bonds. It can raise A dollars annually to pay interest on the bonds and establish a sinking fund that shall yield 4 per cent. and mature the bonds in 40 years.

1st. When A is available to start sinking fund at time of issuing the bonds.

Let B be the amount of bonds to be issued.

At end of first year, $A(1.04) + A - .06B$.

At end of second year, $A(1.04)^2 + A(1.04) + A - [.06B][(1.04) + 1]$.

At end of third year, $A[(1.04)^3 + (1.04)^2 + (1.04) + 1] - [.06B][(1.04)^2 + (1.04) + 1]$.

At end of fortieth year, after multiplying and dividing by $(1.04 - 1) = .04$, we have,

$$A\frac{(1.04)^{41} - 1}{.04} - .06\frac{(1.04)^{40} - 1}{.04}B - B = 0.$$

To show how simply this is done, we write out

$$\begin{aligned}
\log 1.04 &= .017033, \\
\log 1.04^{40} &= .681320 \therefore 1.04^{40} = 4.8010, \\
\log 1.04^{41} &= .698353 \therefore 1.04^{41} = 4.99306.
\end{aligned}$$

For those afraid of logarithms it is not bad to take the square times the square to get the fourth power; the fourth by the fourth then by the second power to get the tenth; the tenth by the tenth and finally the twentieth by the twentieth; especially if you multiply only for the figures that will become significant in the result, dropping off the end figures.

From the above figures and formula, we have,

$$\begin{array}{rr}
 & \underline{.04\ 3.8010} \\
 & 95.025 \\
 & \underline{.06} \\
 & 5.70150 \\
\underline{.04\ 3.99306} & \underline{1} \\
99.8265A = & 6.7015B
\end{array}$$

From this you determine either the bond issue for a given tax levy, or the tax levy A necessary to issue a given amount of bonds,

Second, in case the tax levy A is available only when the first interest on the bonds is due the formula may easily be seen to be

$$A\frac{(1.04)^{40}-1}{.04}-\left[.06\frac{(1.04)^{40}-1}{.04}+1\right]B=0.$$

When A is $20,000 the respective values of B are $297,922 and $283,593.

Although these formulas are to be found in texts on investments, the reader is usually not led to see how he can adjust them to his own immediate needs, or devise other formulas. This fact and the presentation of a concise form of solution furnish excuse for this note.

The second class of problems that come, deals with the theory of probability in its native state, *i. e.*, respecting games. The question sent in "to decide a wager" was: In a game of auction pinochle, the deck containing 48 cards, two of each color from 9 to ace, three players each holding 15 cards and 3 in the blind, what chance has a player, who has neither of the two aces of hearts in his hand, of drawing one ace of hearts from the blind?

After inquiry about games, of which the writer is profoundly ignorant, it is known that the solution may be made most clear to anyone knowing the elements of the theory, as follows:

Probability of getting a hand without either ace of hearts is

$$\frac{{}_{46}C_{15}}{{}_{48}C_{15}}=\frac{33\cdot 32}{48\cdot 47}=\frac{22}{47}.$$

Probability of getting 3 in the blind including at least one ace of hearts is

$$\frac{{}_{33}C_{3}-{}_{31}C_{3}}{{}_{33}C_{3}}=\frac{31\cdot 31\cdot 3\cdot 2}{33\cdot 32\cdot 31}=\frac{31}{176}.$$

Probability that both these events happen is the product of their probabilities, which is $\frac{31}{376}$.

To others it may suffice to put

$$\frac{{}_{46}P_{15}({}_{33}P_{3} - {}_{31}P_{3})}{{}_{48}P_{18}} = \frac{31}{376}.$$

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